Title

Summary of the Research Progress Meeting

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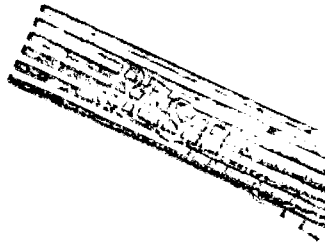
SUMMARY OF THE RESEARCH PROGRESS MEETING

October 21, 1948

R. K. Wakerling

Berkeley, California



Standard Distribution	Copy Nos.
Argonne National Laboratory	1-8
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Atomic Energy Commission, Washington	10-11
Battelle Memorial Institute	12
Brookhaven National Laboratory	13-20
Bureau of Ships	21
Carbide & Carbon Chemicals Corp. (K-25 Plant)	22-25
Carbide & Carbon Chemicals Corp. (Y-12 Plant)	26-29
Columbia University (Dunning)	30
General Electric Company, Richland	31-34
Hanford Operations Office	35
Iowa State College	36
Knolls Atomic Power Laboratory	37-40
Los Alamos	41-43
Mound Laboratory	44-45
National Bureau of Standards	46-47
Naval Radiological Defense Laboratory	48
NEPA Project	49
New York Operations Office	50-51
North American Aviation, Inc.	52
Oak Ridge National Laboratory	53-60
Patent Advisor, Washington	61
Sandia Base	62-63
Technical Information Division, ORDO	64-78
UCLA Medical Research Laboratory (Warren)	79
University of California Radiation Laboratory	80-84
University of Rochester	85-86
Total	86

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Summary of the Research Progress Meeting

October 21, 1948

R. K. Wakerling

Mass Spectrograph. F. L. Reynolds.

During the past year a mass spectrograph has been constructed for the determination of mass assignments of radioactive isotopes from cyclotron bombardments. Figures 1 and 2 show views of the receiver and panel region and the source region respectively.

The ion source consists of a tungsten or platinum filament on which the sample is heated to produce ions by thermal excitation. An alternate source, to produce ions by electron bombardment, is under construction. The ions are accelerated by an electric field of about 8000 volts. The beam is deflected 60° on an arc of 20 centimeter radius. The ions are usually collected on a photographic plate located at the focus. For preliminary experiments with stable isotopes, an electrometer detector is also provided. The radioactive atoms are detected on the plate either by counting methods or by photographic "transfer" techniques similar to those described by Dempster and coworkers[1]. The mass scale on the plate is based on the positions of lines caused by known stable isotopes.

A special feature of the design is the exposed position of both the source and the receiver, which facilitates insertion of the source with the radioactive sample and the removal of the plate after the run. The entire spectrograph may be readily disassembled for cleaning, each unit having vacuum gasket connections. The instrument is of metal construction except the Kovar to glass electrical leads to the source unit. Both the magnet supply current and the 10 kv acceleration supply are measured accurately by potentiometer methods. The magnet supply current is constant to 1 part in 13,000 over a period of an hour. The 10 kv supply is constant to 1 part in 5,000. The magnetic field is sufficient to focus ions of masses as high as 400. The practical resolution of the instrument is about 1200, the dispersion at mass 100 being about 4.0 mm/mass unit. The geometry of the instrument is

round 2%, or about one ion of fifty hitting the slit plate reaches the receiver.

During the four months that the spectrograph has been in operation, a large portion of the operating time has been given to adjustments and runs on non-active samples. Good results have been obtained by thermal ionization techniques on samples of neodymium, rubidium, cesium, barium, lead, sodium, thallium and tungsten obtained by evaporation of nitrate solutions in microgram quantities on tungsten or platinum filaments.

Several successful runs have been made with two radioactive isotopes of rubidium, 5-hr. Rb^{81} and 6-hr. Rb^{82}. These isotopes are of particular interest because their similar half-lives make their differentiation by any other method quite difficult. In fact, the presence of two isotopes was not suspected until the result of the mass spectrograph was obtained.

Bromine in the form of ammonium bromide was bombarded in the 184-inch cyclotron with helium ions of various energies. A small amount of rubidium carrier was added and separated from the target material by strong heating. The residue was dissolved in a small volume of acid and evaporated on the filament for analysis in the mass spectrograph.

The receiver plate ((a) in Fig. 3) was placed emulsion to emulsion against a transfer plate ((b) in Fig. 3) before development. The radiation from the active deposit causes an image on the transfer plate, while the stable isotopes have no effect. After development the isotopes are washed out of the emulsion, so no further measurements are possible.

The plate from a similar experiment was counted with a Geiger counter, placed behind a small slit. The activity at mass 81 decayed with a 5.0-hr half-life, while that at mass 82, which was considerably weaker, decayed with about a 6-hr. half-life.

The 40-day activity which has been assigned to Rb^{84} was also produced in these bombardments, but in yield too poor for detection with the mass spectrograph.

Lewis and Hayden, MDDC-1556, A Mass Spectrograph for Radioactive Isotopes.

Metabolism of Radio-cadmium 109. B. Lamson.

Because of the extremely toxic nature of cadmium a study of its metabolism is important from the point of view of industrial hazard. The material is extensively used in paints, in electroplating and in the manufacture of bearing alloys. In these industries workers are subjected to cadmium fumes and dust particles arising from milling or machining of the metal. A number of deaths have been recorded from cadmium fumes. Small amounts of cadmium have also been used in the treating of certain diseases. The material is one of the most toxic, the LD 100 dose being about 3 mg./kg. of body weight.

Some experiments have been done with animals that have been fed on diets containing 200 parts per million of cadmium. Serious effects were found in these studies. It was discovered that dosages of 250 parts per million in the diet cause eventual death. They showed that the major portion of the material is deposited in the liver and pancreas.

To shed further light on the deposition of this material in the body, experiments have been initiated employing radio-cadmium produced by the d,2n reaction on Ag^{109}. The material was first used in a carrier-free state in 1, 4, 50, and 64 day studies on rats. It was administered intramuscularly, intravenously, and orally to different groups of animals. The quantity administered was small, so that the blood level was never high. From the intramuscular and intravenous studies it was discovered that a major portion of the material was deposited in the liver, kidneys, and pancreas. After one day nearly 100 per cent of the material was found in these three organs. The retention is quite great; at the end of 64 days, for example, the amount in the liver has only decreased from 78 per cent to 62 per cent of the administered dose. It is observed that the material is only excreted at the rate of about 1 per cent per day for the first 4 days and at the rate of .02 per cent per day for the remaining time. The material excreted was principally by way of the feces. It is believed that the cadmium is eliminated with the bile.

There was a considerable similarity in the results for the intramuscular and intravenous injection. However, the results for the oral administration were quite different. It was discovered that very little material is absorbed in oral administration, although the

distribution pattern is quite similar.

Another experiment was done in which one milligram of cadmium carrier was given with the radio-cadmium. Under these circumstances the distribution throughout the body was much the same but the route of excretion was changed, shifting toward urinary excretion. Some decrease in the liver retention was also noted in this case. Photomicrographic studies revealed damage in the liver, kidneys, and pancreas.

Experiments will be conducted to discover if the elimination of cadmium can be speeded by the injection of various chemicals. The chief of these to be tried will be BAL (British anti-lewisite). In some experiments with zinc it has been found that the use of BAL cuts the mortality by 50 per cent and raises the excretion 400 per cent. Some success has also been achieved using BAL in other types of metal poisoning, notably with arsenic.

High Energy Gamma Rays from the 184-inch Cyclotron. B. Moyer.

The experiments on the detection of high energy gamma rays from the 184-inch cyclotron reported in the Progress Meeting for September 30 have been continued and some preliminary results obtained on the cross section for the production of 70 Mev quantum. It must be emphasized that the results are only tentative, since a complete analysis of the errors involved in the measurements has not been made.

With the apparatus being used, the detector subtends at the target a solid angle of 10^{-6}. A .0001 tantalum detector is employed. This has an equivalent thickness of .07 radiation units, where the radiation unit is defined as the thickness required to reduce the energy of energetic electrons by a factor of 1/e.

To begin with, the production of 70 Mev gamma rays was made the object of the measurement. At this energy the probability for pair production in one radiation unit of tantalum is approximately .6, which means that in the .0001" detector used the probability for pair production by 70 Mev quanta is about 4 per cent. On this basis the efficiency for detecting such gamma rays with the instrument in use is approximately 10^{-8}. A one microampere per sq. cm. beam of deuterons was employed, and the cyclotron target was assumed to contain

0^{-23} cm.^{2} atoms for the beam to strike, that is .01 events per second at 70 Mev should be detectable. This is equivalent to saying that the cross section for production of 70 Mev quanta is 10^{-23} cm.^{2}.

The counter system employed for the detection of the pairs produced in the Ta detector involves triple coincidence between three counters arranged as shown in Figure 4. Between the second and third counters a 1/4 inch sheet of lead is employed to reduce the accidental number of coincidences. With this arrangement the ratio of the number of coincidences to the product of the energy width and the number of counts on the monitor detector as a function of energy exhibits the form shown in Figure 5 for the cases of lead and beryllium targets. The beryllium target was 1/2 inch in thickness, while the lead target had a thickness of .1 inch. The difference between the results seems to be real, although the points in both cases are somewhat scattered.

These results are preliminary and need to be corrected for the variation of the probability of pair production as a function of deuteron energy. However, it can be said that the corrections involved for energies above 50 Mev are negligible as the following brief table of pair production probability as a function of energy exhibits.

E	P(E)
100	.58
70	.55
50	.52
20	.40
10	.25

Scattering is not the significant factor in this experiment. It is planned to extend this work and to make careful estimates of the experimental errors.

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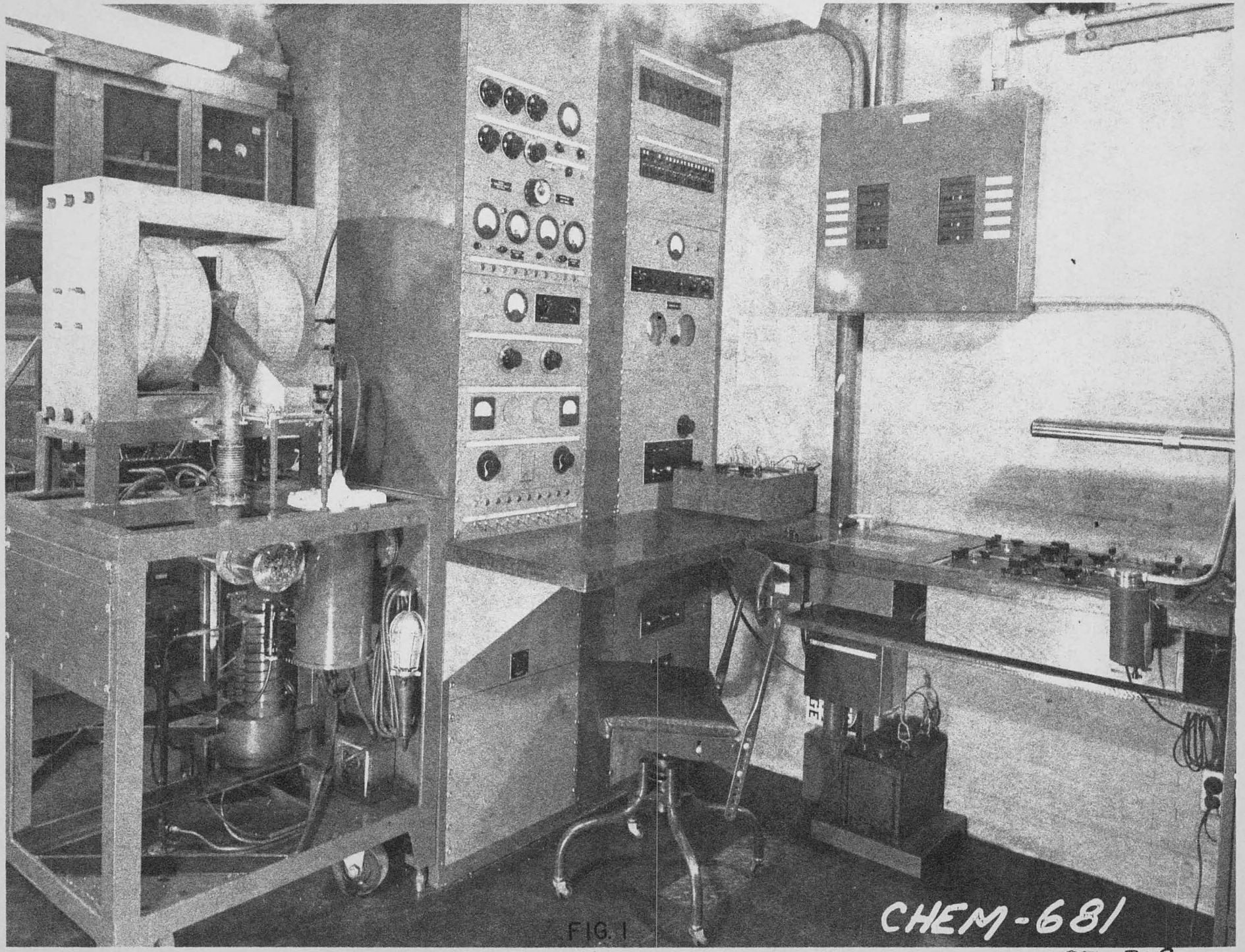
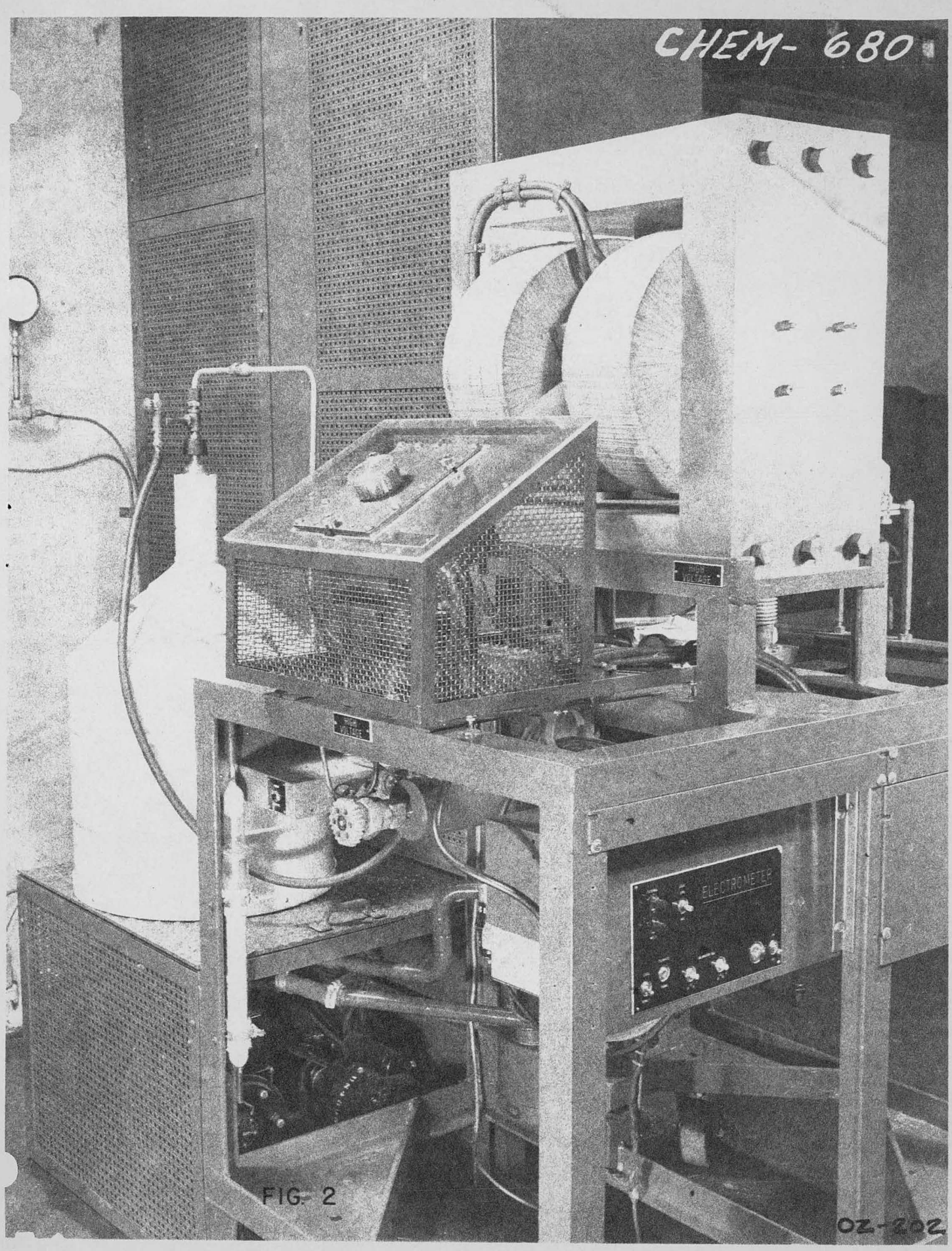


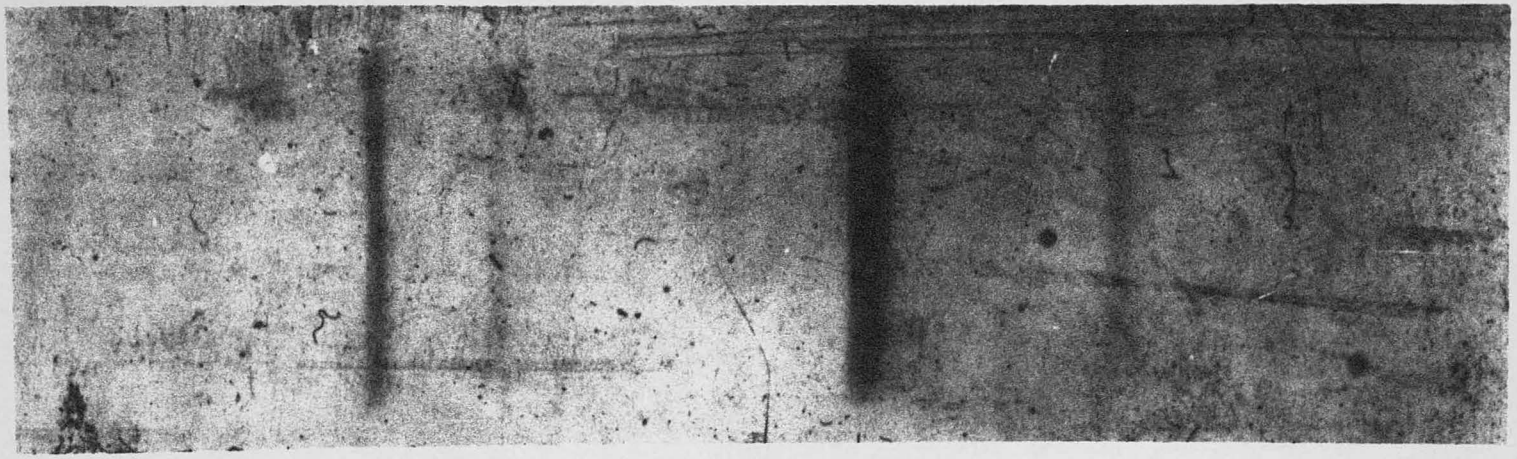
FIG. 1

CHEM-681

OZ-203


CHEM- 680
ELECTROMETER
FIG- 2
OZ-202

a.



b.

81 82 85 87

FIG. 3

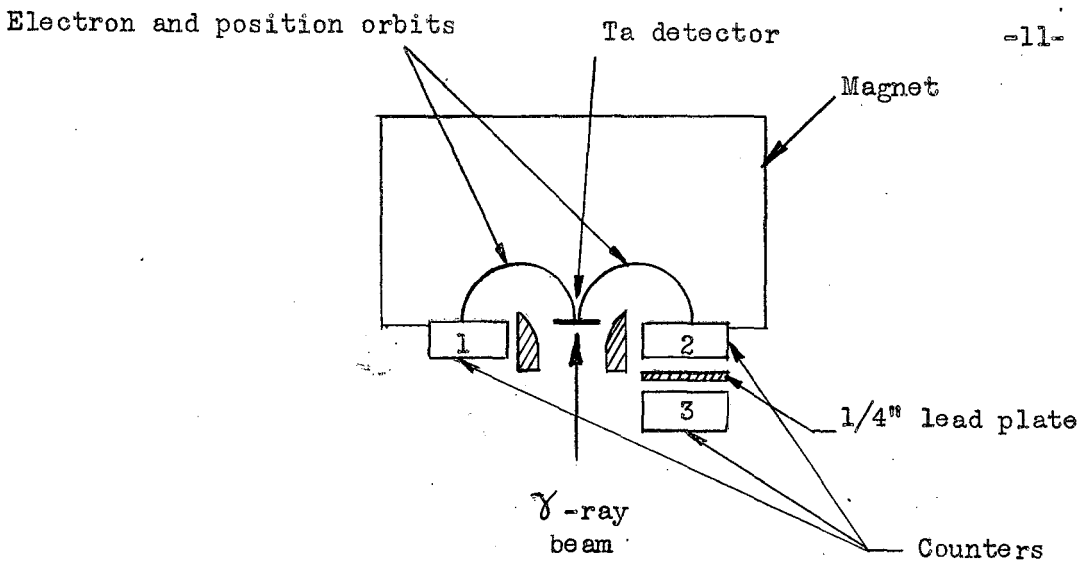

Electron and position orbits
Ta detector
Magnet
1
2
3
1/4" lead plate
γ-ray beam
Counters

Fig. 4

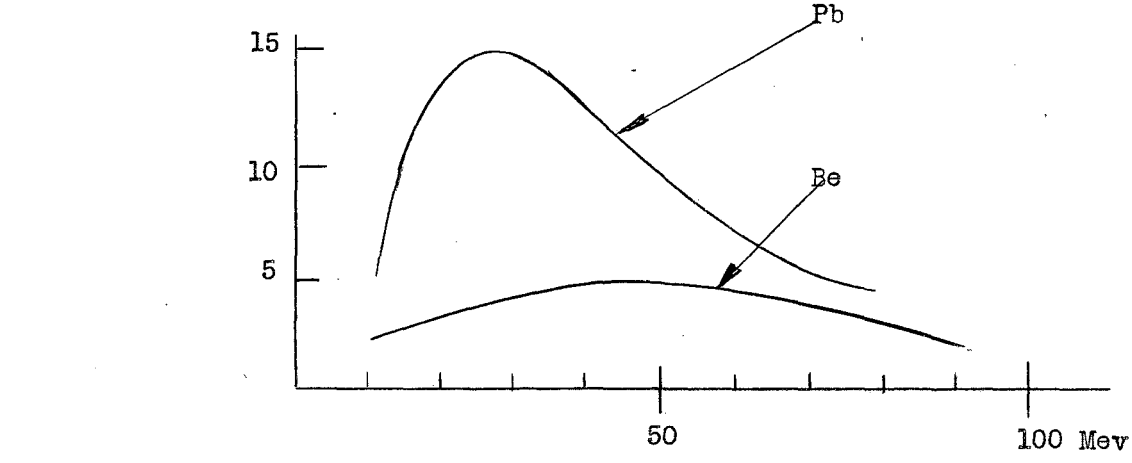

No. of Coincidences
Δ E x Monitor Counts
15
10
5
Pb
Be
50
100 Mev

Fig. 5